Y = mx + b **Really is Found in Real-Life Situations**

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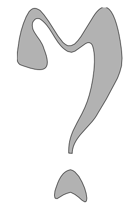
Have any of your middle grade students ever asked you what $y = mx + b$ has to do with them? You have probably wrestled with such a question for many of the algebraic concepts you strive to develop in your students. Not surprisingly, another series of questions is certain to emerge. Is it really possible to make concepts such as the slope and y-intercept of a line meaningful to middle graders? Is there a way of making these concepts "stick" so they can be applied in other subjects? Can this be done without an unreasonable amount of preparation time?

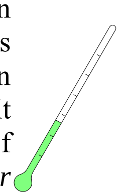


Finding an effective and efficient means of addressing these questions is an on-going task for middle grades teachers of mathematics. For over 10 years the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) has provided the impetus for creating learning environments that actively engage students in learning significant mathematics and that promote students' connection making both within mathematics and among other disciplines. Selecting appropriate tools, instructional methods, and assessment techniques that support such a classroom environment has become increasingly difficult if not overwhelming, due in large part to the magnitude of choices. Yet the selection of one type of tool has been made quite clear in *Principles and Standards for School Mathematics* (NCTM, 2000) through its Technology Principle: Technology is essential in teaching and learning mathematics.

This article may be thought of as a reminder of how technology such as a Calculator-Based Laboratory (CBL), a graphing calculator, appropriate probes, and web sites can be used to make the concepts of slope and y-intercept come alive for middle graders. Specifically, two well-known CBL activities that offer different settings for illustrating the concepts of slope and y-intercept are reviewed and a suggested extension utilizing web sites is offered. It is an added bonus that by capturing and interpreting real-life phenomena, concepts from both mathematics and science can be connected and reinforced.

Two Temperatures

An increasingly diverse and mobile student population that now comprises our classrooms has sparked renewed interest in the relationship between temperatures measured in degrees Celsius and degrees Fahrenheit. Students new to this country or those who visit other countries are confronted with the task of translating between these two temperature scales. Typically, conversion between Celsius and Fahrenheit measures has been the responsibility of science teachers. However, an investigation of the Celsius-Fahrenheit relationship such as the one found in *Data Collection Activities for the Middle Grades with the TI-73, CBL, and CBR* (Johnston & Young, 1998) involves students in the creation of a conversion formula for changing from one measurement unit to the other. This type of activity can then be used to clearly establish the role of the slope and y-intercept in the conversion process.



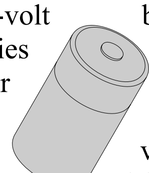
Although many variations are possible, the basic set-up for this investigation requires a CBL, two temperature probes, a graphing calculator such as the TI-73 or TI-83 Plus loaded with the appropriate program, a unit-to-unit link cable, a cup of lukewarm water, and a cup of ice. One of the temperature sensors is connected to the CBL's Channel 1 and the other to Channel 2, with each of the probes set to collect data in different units. Once the two temperature sensors have been taped or tied together so as to ensure they are measuring the same portion of the water, the probes are placed in the cup of lukewarm water. After several minutes, a temperature reading is taken. The process of adding a few cubes of ice to the water, stirring with the temperature probes, and waiting approximately 5 seconds before taking another temperature reading is continued until approximately 10 data values have been collected.

A Fahrenheit-Celsius plot and a Celsius-Fahrenheit plot are constructed from the collected data. A line of best fit for each plot, which in actuality is an approximate conversion formula, is then created by using the manual fit option or by calculating a linear regression model. Once each best-fit model is established, students identify each slope and y-intercept. The slope concept may be reinforced by having students choose two data points that appear to lie on the regression line and compute the slope between the two points. From this computed slope and one of the data points on each regression line, another conversion formula is derived.

At this juncture two options exist for having students develop the exact conversion formulas relating Celsius to Fahrenheit and Fahrenheit to Celsius. The typical approach is to use the fact that 0°C is equivalent to 32°F and 100°C is equal to 212°F to determine the slope and then the $y = mx + b$ equation. With web access readily available in many schools and students' homes, consider utilizing a combined web-based and graphing calculator approach. Two weather websites, the Weather Channel (*www.weather.com*) and Yahoo! Weather (*http://weather.yahoo.com/*) are particularly appropriate. At the Weather Channel site, students choose Worldwide City Forecasts and then select a city of interest to them. Using the temperature converter that is located on the city's 10-day forecast page, students enter each day's predicted temperature in degrees Fahrenheit (or Celsius) and find the corresponding degrees Celsius (or Fahrenheit). At the Yahoo! Weather site, students select a location or city. When the city's five-day forecast page is displayed, a choice of either a Fahrenheit or Celsius reading is provided. Forecasted temperatures are then recorded by entering corresponding temperatures into separate lists in the calculator, from which a scatter plot can be created and a linear regression determined. A comparison of the steepness and y-intercept location of each of the standard conversion formulas' graphs provides a visual image that enables students to distinguish between the two conversion formulas.

Batteries and Voltage

Many middle graders are the proud owners of a battery-operated CD player. The normal expectation is to be able to listen to their favorite CDs as soon as batteries are inserted into the player. However, experience tells us that this is not always the case. When students are asked how they would go about troubleshooting given this situation, typical responses might include checking that the quantity and recommended type of batteries are correct and verifying that the batteries have been properly inserted. This advanced organizer sets the stage for a student investigation of how much power is provided to their CD player by the batteries. Such an investigation, adapted from the one found in *Getting Started with CBL2* (Texas Instruments, 2000), involves students in measuring the voltage of each battery in the CD player and the voltage of batteries in a series. Choike (2000) suggests that algebra lessons, whenever possible, should be molded around the interests of students and should emphasize conceptual understanding.



Materials required for this activity include a CBL 2, voltage sensor, graphing calculator, unit-to-unit link cable, 4 to 5 same size 1.5-volt batteries (AA or AAA), and a ruler with an indentation down the center for holding batteries in place. After the voltage sensor is connected to the CBL2 in Channel 1 and the calculator and CBL2 are connected via the link cable, the voltage of each of the batteries is measured by holding the appropriate voltage leads to the appropriate terminal and voltage readings recorded. Two batteries are then lined up in series with a positive terminal (+) touching a negative terminal (-) and a voltage reading taken and recorded. This process is continued for three, four, and five batteries in a series.

Assuming that all batteries are close to the same voltage, students should be able to describe a pattern in the values of successive voltages based on either a numerical or graphical representation. From these values, a prediction for the voltage of "*X*" batteries in a series is made and a prediction equation developed. The linear curve fit (linear regression) option on the scatter plot data is employed and illustrates that the total voltage increases by approximately the slope value of the fitted line. Students determine how the average voltage of the individual batteries compare to the slope of the linear regression equation and then explain how the values of the slope and *y*-intercept are related to the power provided to their CD player by the batteries.

It is every teacher's desire to create a classroom environment that reflects the vision of what is referred to as a *Standards*-based classroom.

Summary

Both activities described above involve thinking of slope as a rate of change. Crawford and Scott (2000) suggest that developing slope as a rate of change through visualization, verbalization, and symbolization builds conceptual understanding and insight into the importance of mathematics. The Algebra Standard for Grades 5-8 (NCTM, 2000) specifies that students should explore relationships between symbolic expressions and graphs of lines, while paying particular attention to the meaning of intercept and slope. It is every teacher's desire to create a classroom environment that reflects the vision of what is referred to as a *Standards*-based classroom. The technology-based activities reviewed above, as well as countless others, offer a path toward realizing that vision in the middle grades mathematics classroom.

References

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